A SILENT BOUNDARY METHOD WITH THE MPM FOR SIMULATING FILM DELAMINATION

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In multi-scale numerical simulation of failure evolution, usually only a finite region of the problem domain is discretized and analyzed to save computational cost. If no special boundary treatment is used to prevent outwardly radiating waves from reflecting from the boundary of computational region, errors will be introduced into the results. To absorb, rather than reflect, the outwardly radiated energy, Lysmer and Kuhlemeyer [1] proposed a treatment of absorbing boundaries by applying viscous damping forces along the computational boundary. For simulating dynamic failure involving decohesion or separation of continuum, the conventional mesh-based methods are often awkward. Based on the framework of the material point method (MPM) [2] which does not employ fixed mesh connectivity, an effective silent boundary method with the use of Lysmer and Kuhlemeyer's scheme is being developed to simulate the discrete failure pattern in a multi-scale problem. By discretizing a small computational domain instead of the whole problem domain, the proposed procedure could effectively simulate the dynamic failure evolution involving multi-degrees of discontinuities with zoom-in and zoom-out options.

To resolve the inherent difficulty in enforcing moving natural boundary conditions in the MPM, a concept of boundary layer is introduced to implement the continuously distributed viscous damping forces along the moving computational boundary. In order to evaluate the effectiveness of the silent boundary method with the MPM in eliminating the reflection of radiating stress waves, a parametric study by applying different boundary conditions is conducted on a plane strain problem. The application to the model-based simulation of multi-degree discontinuities involved in film delamination [3] then demonstrates the potential of the proposed computational procedure in simulating the evolution of multi-scale dynamic failure with the use of a moving domain of influence.

References

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